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BUDGET EFFECTS OF THE CHALLENGER ACCIDENT

Staff Working Paper
March 1986

The Congress of the United States
Congressional Budget Office

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PREFACE

The loss of the space shuttle Challenger will have repercussions for the entire national space program. In response to a request from the Chairman and the Ranking Minority Member of the Senate Committee on Commerce, Science, and Transportation, this staff working paper provides preliminary estimates of the effects of the Challenger accident on the National Aeronautics and Space Administration budget for fiscal years 1986 and 1987.

The paper was written by David H. Moore of CBO's Natural Resources and Commerce Division, under the direction of David L. Bodde and Everett M. Ehrlich. Richard Mudge of the Natural Resources and Commerce Division and Paul DiNardo of CBO's Budget Analysis Division made valuable contributions at all stages of the project.

The manuscript was edited by Patricia H. Johnston and prepared for publication by Kathryn Quattrone.

Rudolph G. Penner
Director

March 1986

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SUMMARY

The Challenger accident probably will raise total spending for the National Aeronautics and Space Administration (NASA) in fiscal years 1986 and 1987, even if a new orbiter is not procured. An estimate by the Congressional Budget Office (CBO)--based on very preliminary NASA data--of the needed net new budget authority is $142.5 million over 1986 funding and $115.5 million over the President's 1987 request. It should be emphasized, however, that these estimates may change significantly, depending on the cost of investigating the Challenger accident and on whether the investigation leads to modifications of the shuttle system itself or of NASA operating practices.

The Congress could meet these new costs either by authorizing new funds or by cutting other spending within the NASA budget. One possible area in which to reduce NASA spending over the next two to three years is the research and development (R&D) function, since the loss of shuttle capacity will lead to a dramatic reduction in shuttle flights available to launch R&D payloads during this period. Once the system returns to regular operations, pressing national security needs will fill most of the available flights for several years, thus delaying the launch of major scientific payloads--which require large R&D expenditures-- by as much as three years beyond their original launch dates.

The budgetary effects of the accident can be broken down into two categories. The first, "reconstitution" costs, includes the expenses of the investigation, any shuttle system modifications suggested by the investigation, and the replacement of equipment lost in the accident.[1] The second class of effects includes those costs and savings that result from the lower flight rate forced on NASA by the loss of the Challenger. Currently, not all the reconstitution costs of the accident are known. Most important, the cost of the investigation and of modifying the system to provide for safe flight cannot be estimated yet. According to NASA's preliminary estimates, replacing capability lost in the explosion (exclusive of the orbiter)

1. The cost of a fourth orbiter, however, is not construed as part of this replacement cost. This analysis assumes that the Congress will wish to determine independently whether a new fourth orbiter should be constructed.

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and modifying the system will require new expenditures of $240.5 million in 1986, $245.5 million in 1987, and related spending of $205 million in future years. Of this amount, $350 million will be spent to modify the shuttle system--$200 million in 1986 and $150 million in 1987. According to CBO's preliminary analysis, these NASA cost estimates may be low. Net savings in NASA operations may offset these new costs by $98 million in 1986 and $130 million in 1987. Of this amount, $45 million in 1986 and $124 million in 1987 would be saved by not operating the shuttle. Additional net savings--$53 million in 1986 and $6 million in 1987--are estimated for research and development and for space tracking and data communications activities.

This analysis deliberately excludes consideration of longer-term budgetary issues, such as the procurement of a replacement orbiter. Provision of a new fourth orbiter would raise a number of significant issues for both space policy and the NASA budget. The cost of replacing the orbiter and the existing orbiter spare parts that would be consumed by a new orbiter is estimated by NASA to be $2.4 billion over four years. At the same time, the out-year operational costs of the shuttle system are likely to increase as the accident promotes more conservative and costly operational procedures. An expendable launch vehicle program to fill the deficiency left by the loss of an orbiter could be at least as expensive--for example, the Air Force recently purchased 10 rockets for $2 billion, roughly the cost of one shuttle.

Thus, purchasing either a small fleet of expendable launch vehicles or a new orbiter will raise serious budgetary concerns. Moreover, implementing NASA's preaccident suggestion of real increases in its budget to finance the space station program would require even greater resources. Together, procurement of a new orbiter, more costly shuttle operating procedures, and the space station program could require an additional $1 billion in NASA's annual budget through 1990. The Congress will be concerned about the budgetary effects of these issues not only in 1986 and 1987 but also well into the next decade, calling into question the future federal role in the commercial and scientific development of space.

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CHAPTER I

INTRODUCTION AND METHODOLOGY

This paper provides a preliminary analysis of the effects of the explosion of space shuttle Challenger on the NASA budget for fiscal years 1986 and 1987. (All years in this report are fiscal years unless stated otherwise.) The report is confined to the 1986 and 1987 NASA budgets, although the effects of the accident will be felt in other parts of the federal budget, primarily national defense, and will affect the NASA budget beyond fiscal year 1987. The analysis is restricted to current policy, and does not assume any major new procurement of space transportation capacity. The potential costs of a fourth (replacement) orbiter are not part of current policy and, therefore, are presented for illustrative purposes only. The analysis is based on the assumptions that shuttle operations are suspended for 12 months and that the system is restricted to six flights through the remainder of 1987, 14 in 1988, and 16 in 1989. 1/

The loss of space shuttle Challenger will affect the two principal components of the NASA budget: space flight, control, and data communications (known as space flight); and research and development (R&D). Together these activities account for about 80 percent of NASA budget authority. Table 1 presents NASA's 1986 funding and the Administration's proposal for 1987 at a broad level of aggregation. The major costs of the accident are the replacement of lost equipment and the correction of problems identified during the investigation, which are difficult to quantify until the investigation is completed. The accident also will affect the operations of NASA, generating both costs and savings in the space flight and R&D components of the NASA budget.

Savings and cost estimates are drawn from preliminary data provided by NASA. Final accident costs are as yet unknown, and NASA has not submitted to the Congress a formal plan to cope with the budget consequences for 1986 and 1987. This paper, therefore, represents a summation of knowledge available to date. Eventual budget outcomes may differ substantially from those presented here.

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1. For background on the space shuttle program, see Congressional Budget Office, *Pricing Options for the Space Shuttle* (March 1985).

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TABLE 1. NASA'S 1986 FUNDING AND THE ADMINISTRATION'S 1987 BUDGET REQUEST, BY MAJOR SUBFUNCTION
(By fiscal year, in millions of dollars)

Subfunction	1986	1987
Research and Development	2,638.3	3,003.1
Space Flight, Control, and Date Communications	3,258.2	3,069.0
Construction of Facilities	133.3	181.3
Research and Program Management	1,303.4	1,441.0
Total	7,333.2	7,694.0

SOURCES: Congressional Budget Office, using Housing and Urban Development and Independent Agencies Appropriation Bill, Public Law 99-160, and *Budget of the U.S. Government for Fiscal Year 1987*.

The first set of costs generated by the accident are those to return the shuttle system to flight and to restore programs directly affected by the accident to their prelaunch status. NASA refers to these as "reconstitution costs." They include the cost of the investigation and resultant system modifications; replacement of lost equipment, the tracking and data relay satellite (TDRS), and its upper-stage rocket booster;[2/] and continued operation of the ground tracking network in the absence of the substitute TDRS system.

Second, the accident also will affect the postaccident flight schedule, generating both operational costs and savings in the future. Operational savings should occur in the space flight account as a result of flights cancelled while the investigation is ongoing and because of lower flight rates after operations resume. These savings are likely to be offset to a degree, however, by refunds to paying customers booked on the shuttle through 1989 and by higher operating costs once the shuttle system begins to fly again.

2. The shuttle system brings a payload to orbit roughly 200 to 300 miles above the earth. Payloads requiring higher orbits or outward bound to the planets require an upper-stage rocket to propel them toward their destination.

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Because, under current space transportation policy, the shuttle system is the sole means of transportation available to the NASA research and development program, the accident will affect the operation of this major agency function. NASA's 1986 funding and 1987 budget requests include spending for numerous space science payloads scheduled for flight during those years. In addition, the budget includes initial spending for payloads scheduled for launch in years beyond 1987 that may now face deferral. The unavailability of the shuttle system will create new costs, primarily those for storing payloads nearing readiness for launch over the next 12 months and for maintaining program teams while the shuttle is down. Savings will be realized in the R&D account through the postponement of operating costs for payloads that will not have been launched when scheduled. Additional savings could be achieved by stretching out spacecraft construction (such as the upper atmospheric research satellites) and mission preparation for payloads with launch dates that have been forced into the more distant future. These potential savings will depend on the flight opportunities available for discretionary research and development activities once higher-priority (military and commercial) payloads are serviced.

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CHAPTER II

COSTS RESULTING FROM THE CHALLENGER ACCIDENT

The Challenger accident will create two major kinds of costs: reconstitution costs--or those for the investigation and attendant shuttle system modifications and replacement of equipment--and operating costs--or the costs and savings stemming from a lower-than-planned flight schedule. This chapter discusses the NASA cost estimates and their underlying assumptions.

RECONSTITUTION COSTS

Preliminary NASA estimates of shuttle system reconstitution costs are $240.5 million in 1986 and $245 million in 1987. These estimates do not include the cost of an additional orbiter. This first class of costs includes the expenses of the investigation, problem correction (system modification), and the replacement of lost equipment. Table 2 presents a preliminary estimate of these costs, by item, broken down by spending authority in 1986 and 1987 and balance to completion. A balance of $205 million would be deferred to future years. The bulk of these costs concern modifications to the shuttle system that will stem from information gathered by the investigation. NASA estimates these costs will be at least $350 million: $200 million in 1986, and $150 million in 1987.

These estimates could be low. Currently, NASA estimates the cost of the investigation to be between $40 million and $65 million, with salvage costs, the largest single investigation expenditure, ranging from $30 million to $50 million. A program to modify the shuttle solid rocket booster could cost $200 million to $225 million. These items alone would require $240 million to $290 million in funding. At the direction of the Presidential commission, NASA is reviewing 750 "criticality one" components--shuttle system components whose failure would result in the loss of orbiter and crew--and 1,600 "criticality one redundant" items--where only one back-up exists to guarantee against fatal failure of a component.

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ORBITER IMPLICATIONS

Should returning the system to safe operation require modification of a number of critical items, substantial additional costs could arise. For example, NASA preliminarily estimates that the cost of a failsafe mecha-

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TABLE 2. PRELIMINARY CBO ESTIMATES OF REPLACEMENT COSTS (By fiscal year, in millions of dollars) a/

Replacement Item	1986	1987	Balance to Completion
Shuttle System Modification b/	200.0	150.0	0.0
Inertial Upper-Stage Support Equipment	30.0	15.0	10.0
Remote Manipulator Arm	0.0	5.0	25.0
Suits	0.0	10.0	10.0
Orbiter Discovery Modification	5.0	0.0	0.0
Spartan Satellite	5.5	5.5	0.0
Tracking Data Relay Satellite c/	0.0	60.0	160.0
Total	240.5	245.5	205.0

SOURCE: Congressional Budget Office using National Aeronautics and Space Administration data.

a. Does not include a new orbiter.

b. Includes cost of investigation.

c. Accelerated procurement.

nism for the (criticality one) valves that regulate the flow of fuel from the external tank to the space shuttle main engines would be $50 million. Not all potential repairs are as costly, nor is the extent to which they are needed now known. But if only a few of these components require such modifications, the resulting cost, in combination with the estimated costs of the investigation and modifications of the solid rocket booster, could substantially exceed the $350 million originally estimated by NASA.

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OPERATIONAL COSTS

Based on NASA data, CBO estimates that net operational costs will decrease by $98 million in 1986 and $130 million in 1987, as shown in Table 3. As a result of the Challenger accident, savings will occur in both the space flight and R&D accounts of the NASA budget. The accident will, however, also introduce new costs in both accounts, which will reduce gross savings to the lower net level.

NASA estimates net savings in the space flight account of $45 million in 1986 and $124 million in 1987. In any given year, the space flight account includes funds for shuttle flights in that year and in the two following years. Thus, the savings in this account for 1986 and 1987 reflect not only lost flights in these years but also flights lost through 1989. NASA estimates gross savings will be $87 million for 1986 and $154 million for 1987. These savings will be partially offset by the deferral of progress payments and refunds to customers. NASA estimates these offsets will be $42 million in 1986 and $30 million in 1987. When subtracted from NASA's estimates of gross savings in the space flight account, the net space flight account savings of $45 million in 1986 and $124 million in 1987 are realized.

Operational savings also are achieved as lost flights lower the costs of preparing for launch, flying, and analyzing data from research and development spacecraft whose scheduled launches will be significantly delayed. Savings from these are estimated to be $63 million in 1986 and $209 million in 1987. The cost of storing and retaining program teams for these payloads--notably the Hubble Telescope and the Galileo spacecraft--and maintaining the Centaur program will offset these savings by $26 million in 1986 and $173 million in 1987, yielding net savings of $37 million in 1986 and $36 million in 1987.

The Challenger was to have lifted a tracking and data relay satellite to orbit, which would have permitted a phase-out of NASA's groundtracking network. Operating this network will add to NASA costs until a replacement satellite exists. NASA states that the loss of the tracking satellite will result in total tracking system cost savings of $16 million in 1986, but that new operational costs of $30 million will be necessary in 1987. Adding the space flight account net savings of $45 million in 1986 and $124 million in 1987 and the other operational net savings of $37 million in 1986 and $36 million in 1987, and incorporating $16 million in new savings in 1986 and $30 million in new costs in 1987 for the tracking network, yields net shuttle operational savings of $98 million in 1986 and $130 million in 1987.

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TABLE 3. PRELIMINARY CBO ESTIMATES OF OPERATIONAL COSTS AND SAVINGS (-) a/
(By fiscal year, in millions of dollars)

	1986	1987
Shuttle Operations	-45	-124
Spacelab, Other Support Equipment, Payload Operations and Support	-31	-58
Centaur Program Maintenance	0	50
Orbital Manuever Vehicle Development	0	-20
Hubble Telescope	0	68
Galileo	10	48
Ulysses	3	0
Magellan	13	7
Physics and Astronomy, and Planetary Exploration Operation	-12	-98
Upper Atmospheric Research Satellite Development	-20	-33
Tracking Operations	-16	0
Ground Network Maintenance	0	30
Total	-98	-130

SOURCE: Congressional Budget Office.

a. Based on National Aeronautics and Space Administration data.

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CHAPTER III

ALLOCATION OF EFFECTS OF THE CHALLENGER ACCIDENT IN THE NASA BUDGET

The cost of the Challenger accident will fall primarily upon the NASA budget subfunction space flight, control, and data communications. The research and development subfunction is the major potential offsetting source of savings in the NASA budget should the Congress choose to limit new funding. Savings in this account, while not desirable in and of themselves, may be necessary for this purpose. Two possible sources of savings are space station development funding and scientific programs experiencing launch delays because of limited flight opportunities.

SPACE FLIGHT, CONTROL, AND DATA COMMUNICATION

The preliminary estimate of the cost of the accident suggest new net spending requirements in this account of $174 million above NASA 1986 funding and $146 million above the 1987 NASA request. Table 4 suggests how the costs and savings estimated in Chapter II might fall under the major components of the space flight subfunction. New expenditures are likely to be needed in the space flight account stemming from the cost of the investigation, modifications of the shuttle system resulting from the accident, and the cost of maintaining the ground tracking network. These costs are estimated to be $277 million in 1986 and $300 million in 1987. Lower shuttle operational costs (net of commercial and foreign customer refunds and deferrals) and tracking operational savings are the major offsetting budget saving reflected in this account--or $103 million in 1986 and $154 million in 1987.

Unanticipated costs of the investigation and subsequent shuttle modifications would probably fall in this subfunction. Moreover, if the Congress should decide to make new investments in space transportation, new space flight expenditures could increase further. For example, a preliminary NASA estimate of the cost of procuring a new orbiter and replacing the spare parts used to produce that orbiter projects required new budget authority of $263 million in 1986 and $702 million in 1987, out of a total cost of $2.4 billion. The orbiter, if ordered today, would be available in 1990.

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TABLE 4. ACCIDENT COSTS AND SAVINGS (-) FOR SPACE FLIGHT, CONTROL, AND DATA COMMUNICATION BUDGET SUBFUNCTION, BY MAJOR COMPONENT (By fiscal year, in millions of dollars of budget authority)

Major Component	1986	1987
Shuttle Production and Operational Capability		
Initial budget authority	929.8	745.4
Accident costs		
Investigation shuttle system modification [a]	200.0	150.0
Inertial upper-stage airborne support equipment	30.0	15.0
Replace remote manipulator system	0.0	5.0
Replace space suits	0.0	10.0
Modify Discovery orbiter for Centuar	5.0	0.0
Space Transportation Operation		
Initial budget authority	1,650.8	1,524.7
Accident costs		
Deferred payments and refunds	42.0	30.0
Accident savings		
Reduced flight rate	-87.0	-154.0
Space and Ground Networks and Data Communications		
Initial budget authority	677.6	798.9
Accident Costs		
Tracking and data relay satellite [b]	0.0	60.0
Maintain ground stations	0.0	30.0
Tracking operations	-16.0	0.0
Total		
Initial Budget Authority	3,258.2	3,069.0
Net Accident Costs	174.0	146.0

SOURCE: Congressional Budget Office, based on NASA data.

a. Includes cost of investigation.

b. Accelerated procurement.

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RESEARCH AND DEVELOPMENT

Preliminary NASA estimates of net budget savings in the research and development subfunction are $37 million in 1986 and $36 million in 1987. In 1986, $63 million in savings are estimated, primarily because of lower Spacelab mission preparation and support spending, and because of spending stretchouts in the Upper Atmospheric Research Satellite program. These are offset by new costs of $26 million to store payloads and a loss of savings--forced by the disruption of the launch schedule--that were to be achieved by allowing the Magellan and Galileo spacecrafts to share flight equipment. This yields net savings of $37 million in 1986. Preliminary savings in 1987 are estimated at $209 million, attributable in large part to Spacelab mission preparation and support, and reduced costs for the operation of physics and astronomy payloads and planetary exploration support. New 1987 funding requirements of $173 million partially offset these savings, reflecting storage and reprogramming necessitated by launch delays of major payloads, yielding net savings of $36 million in that year. These net savings estimates can be compared to program level funding of approximately $775.2 million in 1986 and $887.5 million proposed for 1987 that may be affected by the accident. 1/ Space station funding of $205 million for 1986 and a requested $410 million for 1987 adds to the total funds where savings might be found. Table 5 presents the research and development funding at the program level as appropriated in 1986 and requested by NASA prior to the accident.

NASA estimates of research and development cost savings appear conservative. Limited flight opportunities through 1988 could permit more significant savings to offset reconstitution costs partially if the Congress chose this course. This contention is based on a comparison of a probable post-accident flight rate and payload schedule with NASA's preaccident schedule.

Reduced budget authority for research and development are not suggested as a painless or preferable offset to higher shuttle system expenses, but as one course of action open to the Congress should overall budget pressures require no new NASA expenditures above 1986 funding or the President's 1987 request.

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1. The 1986 estimate does not include the effects of the Balanced Budget Act sequestration. Assuming a 4.3 percent reduction, 1986 funding falls to $741.3 million.

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TABLE 5. MAJOR COMPONENTS AND PROGRAMS ELEMENTS IN THE RESEARCH AND DEVELOPMENT SUBFUNCTION WITH SAVINGS OPPORTUNITIES, 1986 FUNDING AND 1987 ADMINISTRATION'S REQUEST (By fiscal year, in millions of dollars of budget authority)

	1986		1987	
	Major Component	Program Element	Major Component	Program Element
Space Station System Definition	205.0		410.0	
Space Transportation Capability Development	437.0		465.0	
Spacelab		92.0		89.0
Payload and support equipment		63.9		72.6
Tethered satellite system		17.5		11.6
Orbital maneuvering vehicle		10.0		70.0
Space Science and Applications				
Physics and Astronomy	607.0		539.0	
Hubble space telescope operation and maintenance		87.7		137.6
Shuttle/spacelab		108.3		115.1
Gamma ray observer		87.3		51.5
Explorer development		18.0		23.0
Life Science	70.0		75.0	
Flight experiments		34.0		36.7
Planetary exploration	353.0		323.3	
Galileo development		54.2		
Ulysses development		5.6		
Galileo operations		10.5		48.0
Ulysses operations		2.3		5.3
Solid earth observation	74.9		74.1	
Shuttle/spacelab		31.7		32.1
Environmental observation program	289.9		367.9	
Payload and instruments		5.6		12.0
Upper atmospheric research satelite		124.0		152.0
Materials processing	35.0		43.9	
Experiments operations		22.6		31.0
Total, Program Elements		775.2		887.5

SOURCES: 1986--Congressional Budget Office, using Housing and Urban Development and Independent Agencies Appropriation Bill, Public Law 99-160.
1987-- *The Budget of the U.S. Government for Fiscal Year 1987.*

NOTE: The categories listed in this table present those areas in which savings could be achieved because of restricted shuttle flights. The dollar amounts do not represent actual savings.

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THE POSTACCIDENT FLIGHT SCHEDULE AND RESEARCH AND DEVELOPMENT PAYLOADS

The shuttle flight and payload schedule as released by NASA in November 1985 presents for each flight an anticipated launch date, designated orbiter, crew, launch site, major and minor payloads through August 1988 and annual flight rates through 1991. The list is necessarily incomplete in that the payloads carried by flights dedicated solely to Department of Defense (DoD) missions are not listed, nor are smaller NASA and private sector payloads. With reduced system capability, stacked-up national security payloads from 1986 and 1987, and advanced requirements for 1988 leave little if any room on the manifest before 1989 for discretionary space science or new paying commercial and foreign payloads.

The postaccident flight rate and payload schedule used for this analysis are based on two assumptions. First, this report assumes a post-accident flight rate below that anticipated by NASA before the accident. Table 6 presents the preaccident annual flight rate assumed by NASA, the postaccident flight rate assumed in this analysis, and the flights lost as a result of the accident for fiscal years 1986 and 1987. Second, the current policy for payload priorities is maintained. In ranking order of priority,

TABLE 6. PREACCIDENT AND POSTACCIDENT ANNUAL FLIGHT RATES (By fiscal year, in number of flights)

	1986 a/	1987	1988	1989
Preaccident Rate	10	17	18	24
Assumed Postaccident Rate	0	6	14	16
Flights Lost	10	11	4	8

SOURCE: Congressional Budget Office and NASA.

a. Scheduled to fly after Challenger accident.

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shuttle access is assigned to national security projects, payloads that must be launched within a specific time period, payloads from paying foreign and commercial customers, and NASA space science projects that do not require a specific launch time.

Under current policy, a reduced flight rate implies that national security payloads will dominate the postaccident shuttle workload as shown in Table 7. According to the November 1985 NASA schedule, the Department of Defense was to have flown five dedicated flights from February 1986 through January 1987, an additional two dedicated flights during the remainder of fiscal year 1987, and four dedicated flights through August 1988, for a total of 11 dedicated flights. To this total must be added 13 additional DoD payloads scheduled to fly with civil payloads through August 1988 and three TDRS payloads also deemed necessary to national security. Converting these individual launches to flight equivalents at a rate of four payloads per flight produces a conservative additional national security

TABLE 7. DISTRIBUTION OF POSTACCIDENT SHUTTLE FLIGHTS ASSUMING CURRENT POLICY PAYLOAD PRIORITY (In flight equivalents) a/

Payload Group	Number of Flights
National Security b/	15
Planetary Exploration	2
Foreign and Commercial	2
Other NASA	1
Total	20

SOURCE: NASA, *Space Shuttle Payload Flight Assignments* (November 1985).

a. Assumes 20 total flights for fiscal years 1987 and 1988.

b. Eleven exclusively Department of Defense (DoD) flights and 13 other DoD payloads and 3 TDRS payloads coverted to flight equivalents at a rate of 4 payloads per flight.

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demand of four flights, for a total of 15 national security flights through fiscal year 1988, or 75 percent of the 20 flights assumed for this period in the postaccident scenario.

The Ulysses and Galileo spacecrafts are the major research and development payloads with limited launch times. Each will require a flight dedicated solely to the spacecraft.

Thus, of the 20 available flights through fiscal year 1988, only three flight equivalents remain to service paying foreign and commercial customers and discretionary space R&D projects. Fourteen payloads for paying customers are shown through August 1988 on the preaccident schedule, or the equivalent of more than three flights. Even if the equivalent of one flight is launched by other providers, little if any capacity would be available for major discretionary R&D payloads until 1989. Among the most significant delays could be the Hubble Space Telescope, all Spacelab flights, and the Upper Atmospheric Research Satellite.

These estimates of space for payloads are sensitive to changes in launch capacity including changes in the number of shuttle flights and the availability of foreign and domestic expendable launch vehicles. Arianespace probably can provide a limited number of launch opportunities in late 1987 and 1988.[2] Other foreign providers might enter the space market--perhaps the Soviet Union or China. Thus, the possibility exists that shuttle paying customers could be off-loaded to these alternatives. A small portion of the national security demand might also find an alternative path to orbit in the form of modified Titan IIs. On the other hand, the postaccident scenario could be too optimistic. It projects 14 shuttle flights in 1988, a substantially greater number than the system has ever produced in a 12-month period. In the 12 months before flight 61-C, the last successful flight before the Challenger accident, the shuttle flew only nine times. Moreover, should the shuttle system remain grounded more than 12 months, the inventory of national security payloads would grow, delaying further research and development flights.

The results of this scenario are also sensitive to changes in the level of demand for national security payloads. Historically, projected national security demand for launch services has exceeded actual demand.[3] To the extent that the preaccident schedule overestimates national security needs

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2. Arianespace is a European (primarily French) consortium that provides space launches using expendable launch vehicles (rockets).

3. See Congressional Budget Office, *Pricing Options for the Space Shuttle* (March 1985), p. 6.

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or that this demand can be pushed into the future, additional capacity would be available for discretionary space research and development. Space for Strategic Defense Initiative payloads, however, introduces a new element that could lead to actual national security demand equal to or exceeding NASA's 1985 projection.

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CHAPTER IV

POLICY ISSUES

The Challenger accident probably will prompt a reconsideration of many aspects of U.S. space policy. The two most important of these are the shuttle's role as the primary mode of space transportation and the decision to build a space station by the early 1990s. The major policy decision of the 1970s was to shift from unmanned expendable rockets to sole reliance on the shuttle system for space transportation. But even before the accident, the Congress had amended this decision by supporting an unmanned rocket program for the military forces. The Challenger accident may prompt further diversification of launch methods. A second policy issue concerns the timing of the proposed space station. The Congress has provided support for the early stages of a space station program that is intended to begin operations sometime in the early 1990s. Achieving this goal would require substantially greater total spending on space infrastructure over the next five years if the Challenger accident requires new investments in space transportation and higher operating costs for manned space flight.

Space transportation is the central issue of national space policy. Future civil, commercial, and military space options revolve around the choices made in this area. Currently, national policy includes both manned and unmanned access to space and a significant new R&D program to develop a "space plane."[1] The Congress can choose among a number of different options, all of which have significant costs.

The rationale for a new orbiter is based on the demand for launch services. The total demand for space flight over the next 20 years could exceed the capacity of a three-orbiter fleet, and the amortized cost of a new shuttle orbiter is likely to be lower than that of an expendable launch vehicle (ELV) program of equal capacity. Moreover, should another orbiter be lost, a two-orbiter fleet would be incapable of fulfilling even minimum national security needs, let alone civilian research or commercial demand.

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1. The NASA and DoD budget requests for 1987 include funding to begin development of a fully reusable space vehicle capable of taking off like a conventional airplane, reaching low earth orbit, and landing like a conventional airplane.

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But the same facts can be employed to support a national program for ELVs. A second shuttle accident would pose immense security and scientific costs to the nation. Both military and civilian users would need an alternative to the shuttle system. Such an alternative--ELVs--could be provided either directly by a new NASA program or by allowing private firms to compete for supplying unmanned rocket launch services to the federal government. The costs per launch of an ELV program are probably higher than those of a new shuttle orbiter. But this difference can be viewed as an insurance premium paid to provide continuing access to space in the event of another shuttle failure.

Returning the shuttle system to safe operation, procuring a fourth orbiter, and establishing a back-up ELV program would be very costly. Together with a more conservative and probably more costly operating mode for the shuttle system, these additions to the NASA budget could approach $1 billion annually over the next five years. NASA already foresees overall budget increases to construct the space station. Thus, postaccident NASA funding requirements could be substantially higher than current levels.

Lower-cost options consist of various mixes--for example, procuring a fourth orbiter while slowing space station funding and freezing space R&D for several years. Alternatively, while continuing with a three-orbiter fleet and initiating an expandable launch vehicle program would increase costs in the long run, this policy combination could defer these costs until the late 1990s. Such a program would require a concerted effort to limit shuttle use to payloads requiring in-space work so as to relieve demands on the capacity of manned space flight and to reduce accordingly the risk and cost of another shuttle accident.

The policy choices facing the Congress are difficult. Essentially, the choice is between increasing budget authority for space transportation in the near term, thus exempting space programs from the national concensus to lower the deficit, or accepting a slower rate of progress in all aspects of space policy.

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